Electronic Supplementary Information: Controlling Exciton Transport in Monolayer $MoSe_2$ by Dielectric Screening

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RAMAN SPECTRUM

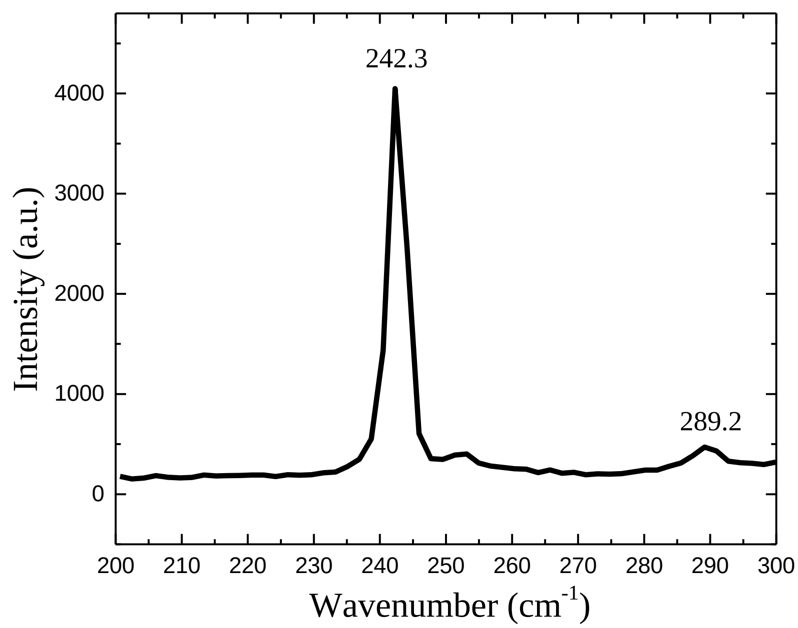

FIG. 1. Raman spectrum of the monolayer $MoSe_2$ on a Si/SiO_2 substrate measured with a Horiba LabRAM HR spectrometer with an excitation wavelength of 532 nm.

RIGID-SHIFT MODEL

We use a rigid-shift model to describe the exciton transport by assuming that the exciton density profile maintains its shape while moving from the covered to the uncoverd regions of the sample. We first construct the initial exciton density profile injected by the pump at $t = 0$. Since the pump spot is centers near the junction, we use a Gaussian function multiplied by a Heaviside function to represent the part of the profile on each side,

$$N_c(x, t = 0) = A_u \exp(\frac{-x^2}{2\sigma^2})\Theta(-x), \tag{1}$$

and

$$N_n(x, t = 0) = A_c \exp(\frac{-x^2}{2\sigma^2})\Theta(x). \tag{2}$$

Where N_c and N_u are the exciton densities injected in the covered and uncovered regions, respectively. The Heaviside function $\Theta(x)$ takes the value of 0 when $x < 0$ and 1 otherwise. A_c and A_u are the magnitude of the profiles and are set to $A_c/A_u = 2.33$, according to the results shown in Figure 2 of the main text. The total initial exciton density profile is thus

$$N(x, t = 0) = N_u(x, t = 0) + N_c(x, t = 0). \tag{3}$$

In this rigid model, we assume that at a certain time after $t = 0$, the whole exciton density profile in the covered side move towards the uncovered side by a displacement d, while the original density profile in the uncovered side remains unchanged. Therefore, the total density at time t is

$$N(x, t) = A_c \exp(\frac{-x^2}{2\sigma^2})\Theta(-x + d) + A_c \exp(\frac{-x^2}{2\sigma^2})\Theta(x). \tag{4}$$

This density profile is convoluted with the probe spot by calculating

$$C(x, t) = \int_{-\infty}^{\infty} P(x)N(x - x_0, t)dx_0, \tag{5}$$

where

$$P(x) = \exp(\frac{-x^2}{2\sigma_p^2}) \tag{6}$$

is the probe intensity profile. The calculated $C(x, t)$ is used to fit the measured profile at the probe delay t, with A_c and A_u adjusted freely to match the height (while maintaining their ratio). The displacement d is adjusted to achieve a satisfactory fit. By repeating this procedure to the profiles measured at all the probe delays, we were able to fit these profiles well, as shown in Figure 3(b), and deduce the displacement as a function of time, as summarized in Figure 4(b).